THE FREQUENCY AND PERSISTENCE OF LOW RELATIVE HUMIDITY IN THE STATE OF WASHINGTON

By GEORGE W. ALEXANDER

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With this paper there are presented tabulated data as to the frequency of occurrence of days marked by a low percentage of relative humidity, within certain stated brackets, and the coefficients of probability of the occurrence of such days. The totals and averages stated are based on the percentages of relative humidity observed at 5 p. m., one hundred and twentieth meridian time, during the 34 years, 1894 to 1927, inclusive, at the Weather Bureau stations at North Head, Seattle, Spokane, and Walla Walla, Wash., and Portland, Oreg. The latter station is included in this study of conditions in Washington as being more representative of conditions in portions of southwestern Washington than any of the stations within the State. Certain adjusted interpolations have been made for periods during which the records at two of the stations were incomplete, so that the resultant calculations may be more closely comparable. It may be stated that the omission from the totals of any of the individual months which include interpolated data would not materially affect the averages stated.

This study has been made in connection with the fire-weather investigations in the Seattle district of the fire-weather warning service. For such a purpose the daily minima of relative humdity at representative field stations would have been preferable as basic data, but these are not available for any extended period. Comparison of such field data as are available with those employed has shown that there is a sufficiently close agreement that the records herein set forth do indicate quite closely the general tendencies in the forested and cut-over areas near the several stations. During April, May, the first half of June, and the latter half of September, the minimum humidity usually occurs before, and is somewhat lower than that at 5 p. m.; during the balance of the season, the midsummer period, during which the fire hazard is usually greatest, the minimum frequently occurs nearly at, and usually is in close agreement with that recorded at that hour. For this reason the upper brackets of percentages chosen for analysis include some humidities that are slightly higher than those ordinarily assumed to denote any material increase in the fire hazard, in the earlier part of the season, but the actual minima of those days may have been at or below the tentatively fixed danger point. During the midsummer season the cumulative effect of preceding periods of low humidity, and the normal seasonal changes in the character of the fuel, particularly the annual growth, tend to increase reaction to the daily changes, so that the figures taken may be considered as very nearly indicating that condition which, in Washington, is commonly called "fire weather."

It should be stated, parenthetically, that while the subject of fire weather is a complex one, and it is recognized that many factors must be considered in any investigation concerning it, in the Pacific northwest, and particularly in the regions west of the Cascade summits, it is assumed by most of the officials of forest protective agencies that, other things being equal, and due weight being given to the seasonal changes in the character of the fuel, the variations in the percentage of relative humidity prevailing over a given area may be accepted as an index of the variations in the fire hazard in that area. Two examples of the weight given the "humidity theory" may be cited.

Early in the season of 1927 the State supervisor of forestry and the chief fire warden of the Washington Forest-Fire Association, charged with forest protection in Washington (outside the national forests), requested that a standard nomenclature, descriptive of the degree of the expected fire hazard, be adopted for all fire-weather forecasts and warnings sent to their wardens and issued to the public through the press and by radio telephone. After discussion, and reference to other protective officials, the following was adopted, as best indicating the expected conditions, and was used thereafter in formulating the fire-weather forecasts for western Washington sections issued from the Seattle office of the Weather Bureau.

Expected minimum humidity	Terminology of the forecast
50 per cent or higher	Fire hazard slight.
49 to 39 per cent, inclusive	Fire hazard moderate.
30 to 38 per cent, inclusive	Fire hazard dangerous.
29 per cent or lower	Fire hazard extremely dangerous

It is recognized that this is an arbitrary classification, which may be changed.

The Logging Insurance Underwriters Association, a "pool" of most of the companies writing insurance on logging equipment and felled timber, has adopted a so-called "humidity warranty," under the provisions of which the assured, by maintaining on his logging operation an approved instrument for recording the percentage of relative humidity and the temperature (the model 1927 hygro-thermograph is generally used for this purpose) and an approved psychrometer, by which the accuracy of the recording instrument may be checked at intervals, and undertaking to cease active logging operations during such time as the relative humidity is below 30 per cent, may obtain a very substantial reduction in his premium rate. This danger point of 30 per cent was also arbitrarily fixed, being something of a compromise. It is still the subject of discussion, although, in the opinion of many of the protective officials, it is sufficiently conservative.

These two practical applications of the humidity theory, the increasing interest in the subject, together with the frequent requests for data as to the conditions to be expected during the fire season, and the frequency of those conditions regarded as dangerous, may serve to indicate the necessity for so detailed an analysis of the occurrence of low humidity as is given in the tabulations that follow.

For convenience, the six months, April to September, inclusive, are considered as the fire season. It is true that abnormally low humidities and fires do occur during the other months, March and October particularly. The low humidities for these two months might have been included in the tabulations, but the occurrences are so infrequent that no particular purpose would be served thereby. During them the degree of fire hazard and the actual amount of damage seem to depend largely on other abnormalities of the weather, more particularly on marked deficits in the seasonable precipitation.

The data for Seattle and Portland are [illegible] representative of general conditions in the interior of western

Washington and the lower western slopes of the Cascades, although the tendencies in the sheltered valleys of the Cascade system are for generally higher temperatures and lower humidities. The nature of the variations at the individual stations depends largely on orographic influence. There is a more limited application of the data for North Head. This station is particularly exposed to maritime influences, low humidity is noted only when the winds are from easterly quarters, outflowing from a HIGH over the plateau. The relative humidity over the area just a short distance inland from this station is generally several per cent lower than on the immediate

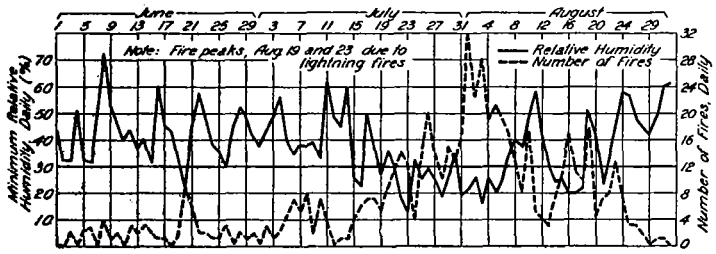

FIG. 1.—Minimum relative humidity and number of fires

coast, hence the high index figure chosen for the tabulation. Conditions here may be taken as representative of the "fog belt" along the Washington coast, to the westward of the Olympics and the Coast Range.

In the eastern sections the humidities at Spokane and Walla Walla are in close correspondence with those in the field in their vicinities, and are somewhat lower than those reported at certain stations on the eastern Cascades and in the Okanogan highlands. The highest percentage tabulated (25) is close to the 5 p. m. normal for July and August at the two Weather Bureau stations. In general, the number of occurrences of subnormal humidities in the field and at these stations is in close agreement. In the practical application of these data, for all sections, it must be borne in mind that the local peculiarities of climate, as shown by the amount and distribution of precipitation, the prevailing temperatures, and the frequency of lightning storms, as well as the local differences in the forest types and fuel materials, must all be given due consideration.

Tables 1 and 2 show the total number and the monthly and seasonal averages of days with relative humidity within the indicated brackets, with the extremes, and the years of their occurrence, for each bracket. Table 3 shows the coefficients of the probability of the occurrence of a day of such relative humidity. Some rather interesting points are brought out by the figures shown.

It will be noted that at all stations, except North Head, the total number, the averages, the probability of the occurrence of humidity within the upper brackets, and the monthly totals for all days with humidity below the upper index figure vary directly with the normal variations in temperature and hours of sunshine throughout the year, and inversely with the monthly precipitation. For North Head the opposite is true for all brackets and for the totals. At Seattle there is an irregularity in the "30 per cent to 26 per cent" bracket, and a marked reversal in the two lowest. At Portland the reversal appears in the two lowest brackets, although to a smaller extent. From these figures we may infer, and the inference is supported by a more detailed study of the individual cases, that marked abnormalities in the percentage of relative humidity on the immediate coast are caused by marked departures from the normal conditions as to wind direction and absolute humidity; specifically, to the dominance of HIGHS over the plateau. These are more frequent in April, May, and September than in June, July, and August. This same inference holds with regard to the more marked abnormalities at Seattle and Portland; that is, extremely low relative humidity is most frequently attendant on the conditions just stated, and the more frequent and less pronounced departures from the normal (shown in the two upper brackets) are due more frequently to those conditions which are favorable for higher temperatures while causing no great change in the absolute humidity. Or, stated more generally, seasonal variations with slight abnormalities appear while the normal maritime climate prevails, the degree of the departures depending on the position of the Pacific HIGH, as causing northerly or westerly winds. The variations abnormal to the season occur when there is an intrusion of the continental climatic régime over western Washington, under the dominance of the plateau HIGH.

For the eastern sections no such abnormalities appear. The peak of probability for all brackets and the totals appears in July, actually in the latter half of that month. The most marked abnormality in the occurrence of low humidity in the northeastern section (Spokane), a decreasing or stationary low humidity as the accompaniment of decreasing temperature and fresh to strong southeasterly winds, is due to local conditions, orographic to some extent, but more to the nature of the terrain over which the southwesterly winds have traveled. This does not show up in the tabulations, as it is more frequent during the warmer months.

Of equal, or perhaps greater, importance than the number of days with low relative humidity is the tendency for recurrence, or occurrence on consecutive days. One day, or a few hours, of such low humidity may not affect the fuel so as to cause any appreciable change in the degree of the fire hazard, but, whatever of effect may be ascribed, it is obvious that the longer the period over which it prevails the greater the ultimate effect on

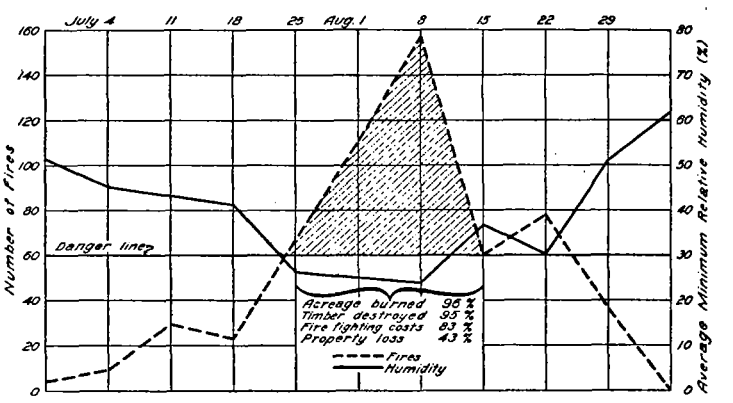

FIG. 2.—Weekly fire occurrence and its relation to average minimum relative humidit

the fire material. To cover this phase, Table 4 shows the number of occurrences of consecutive days of low relative humidity, within the limits and in the several day groups as indicated.

Table 5 shows the average number of periods (groups of one or more days) and Table 6 the average duration of such period, with the extreme, and its date, for each classification. A study of these figures seems to confirm the inferences previously noted as based on Tables 1, 2, and 3. The persistence curve, if expressed graphically, would vary somewhat from that for occurrence, at

Seattle and Portland, but would be altogether in accord at the eastern stations. The abnormalities noted for North Head and for the lower brackets at Seattle and Portland are just as apparent.

In Table 7 there is a chronological list of the occurrences of low humidity at each station during the period covered by this study. This is offered for the information of those who may wish to correlate fire occurrences or other phenomena with the occurrence of low humidity, as these figures are not available in any published data, as are those for precipitation and temperature.

THE OCCURRENCE OF LOW RELATIVE HUMIDITY

Totals and averages are based on the 34-year period, 1894–1927, for all stations.

TABLE 1.—*Total number of days with relative humidity as indicated (5 p. m. observation)*

AT SEATTLE, WASH.

Relative humidity (per cent)	April	May	June	July	August	September	Season
38 to 31, inclusive	83	108	135	163	145	58	692
30 to 26, inclusive	30	22	42	30	26	10	160
25 to 20, inclusive	23	24	17	9	4	7	84
19 or lower	10	7	4	1	0	1	23
Total, 38 or lower	146	161	198	203	175	76	959

AT PORTLAND, OREG.

38 to 31, inclusive	96	102	102	187	175	67	729
30 to 26, inclusive	45	53	52	73	71	34	328
25 to 20, inclusive	60	34	29	28	27	17	195
19 or lower	19	15	15	13	12	15	89
Total, 38 or lower	220	204	198	301	285	133	1,341

AT NORTH HEAD, WASH.

50 to 41, inclusive	14	9	3	3	2	17	48
40 to 31, inclusive	8	3	0	1	2	16	30
30 or lower	3	3	3	0	3	7	19
Total, 50 or lower	25	15	6	4	7	40	97

AT SPOKANE, WASH.

25 to 20, inclusive	164	183	235	262	252	202	1,298
19 to 15, inclusive	78	81	139	280	276	85	939
14 or lower	18	24	51	177	163	22	455
Total, 25 or lower	260	288	425	719	691	309	2,692

AT WALLA WALLA, WASH.

25 to 20, inclusive	107	138	187	268	264	116	1,080
19 to 15, inclusive	37	57	121	227	215	43	702
14 or lower	16	12	34	150	109	8	329
Total, 25 or lower	160	207	342	645	590	167	2,111

TABLE 2.—*Average number of days with relative humidity as indicated, monthly and for season, with seasonal extremes, period 1894–1927*

AT SEATTLE, WASH.

Relative humidity (per cent)	April	May	June	July	August	September	Season	Greatest number	Year	Least number	Year
38 to 31, inclusive	2.5	3.2	4.0	4.8	4.4	1.7	20.6	39	1926	4	1905
30 to 26, inclusive	0.9	0.6	1.2	0.9	0.8	0.3	4.7	13	1927	0	[1] 1913
25 to 20, inclusive	0.7	0.7	0.5	0.3	0.1	0.2	2.5	9	1898	0	[1] 1904
19 or lower	0.3	0.2	0.1	0.03	0	0.03	0.7	4	1926	0	[1] 1904
38 or lower	4.4	4.7	5.8	6.0	5.3	2.2	28.4	65	1926	5	1913

TABLE 2.—*Average number of days with relative humidity as indicated, monthly and for season, with seasonal extremes, period 1894–1927*—Continued

AT PORTLAND, OREG.

Relative humidity (per cent)	April	May	June	July	August	September	Season	Greatest number	Year	Least number	Year
38 to 31, inclusive	2.8	3.0	3.0	5.5	5.1	2.0	21.4	37	1904	7	1925
30 to 26, inclusive	1.3	1.6	1.5	2.1	2.1	1.0	9.6	21	1918	3	1899
25 to 20, inclusive	1.8	1.0	0.9	0.8	0.8	0.5	5.7	17	1918	0	1908
19 or lower	0.6	0.4	0.4	0.4	0.3	0.4	2.6	7	[1] 1895	0	[1] 1899
38 or lower	6.4	6.0	5.8	8.8	8.3	3.9	39.3	69	1918	16	[1] 1912

AT NORTH HEAD, WASH.

50 to 41, inclusive	0.41	0.26	0.09	0.09	0.06	0.50	1.41	5	1896	0	[2]
40 to 31, inclusive	0.23	0.09	0.00	0.03	0.06	0.47	0.88	6	1926	0	[2]
30 or lower	0.09	0.09	0.09	0.00	0.09	0.21	0.56	3	[1] 1922	0	[2]
50 or lower	0.74	0.44	0.18	0.12	0.21	1.17	2.85	9	1926	0	[2]

AT SPOKANE, WASH.

25 to 20, inclusive	4.8	5.4	6.9	7.7	7.4	5.9	38.3	50	[1] 1920	29	1927
19 to 15, inclusive	2.3	2.4	4.1	8.2	8.1	2.5	27.6	44	[1] 1918	12	1909
14 or lower	0.5	0.7	1.5	5.2	4.8	0.7	13.1	38	1895	1	[1] 1902
25 or lower	7.6	8.5	12.5	21.1	20.3	9.1	79.2	113	1924	50	1927

AT WALLA WALLA, WASH.

25 to 20, inclusive	3.1	4.2	5.5	7.9	7.8	3.3	31.8	51	1921	5	1902
19 to 15, inclusive	1.1	1.7	3.6	6.6	6.4	1.3	20.6	46	1924	1	1902
14 or lower	0.5	0.3	1.0	4.4	3.2	0.2	9.7	33	1910	0	[2]
25 or lower	4.7	6.1	10.1	18.9	17.4	4.9	62.2	109	1910	6	1902

[1] And other seasons. [2] Several seasons.

TABLE 3.—*Coefficients of the probability of the occurrence of a day of low relative humidity, as indicated*

AT SEATTLE, WASH.

Relative humidity (per cent)	April	May	June	July	August	September	Season
38 to 31, inclusive	0.081	0.102	0.132	0.155	0.138	0.057	0.113
30 to 26, inclusive	.029	.021	.041	.028	.025	.010	.026
25 to 20, inclusive	.023	.023	.017	.008	.004	.007	.013
19 or lower	.010	.006	.004	.001	0	.001	.004
38 or lower	.143	.153	.194	.192	.166	.074	.154

AT PORTLAND, OREG.

38 to 31, inclusive	0.094	0.097	0.100	0.177	0.166	0.066	0.117
30 to 26, inclusive	.044	.051	.051	.069	.066	.033	.053
25 to 20, inclusive	.059	.032	.028	.027	.026	.017	.031
19 or lower	.019	.014	.015	.012	.011	.015	.015
38 or lower	.218	.194	.194	.286	.270	.130	.216

AT NORTH HEAD, WASH.

50 to 41, inclusive	0.014	0.008	0.003	0.003	0.000	0.017	0.007
40 to 31, inclusive	.008	.003	.000	.001	.002	.016	.005
30 or lower	.003	.003	.003	.000	.003	.007	.003
50 or lower	.024	.014	.006	.004	.005	.039	.015

AT SPOKANE, WASH.

25 to 20, inclusive	0.161	0.174	0.230	0.248	0.239	0.198	0.209
19 to 15, inclusive	.076	.077	.137	.266	.262	.083	.151
14 or lower	.018	.023	.050	.168	.155	.022	.073
25 or lower	.255	.273	.417	.682	.656	.303	.433

AT WALLA WALLA, WASH.

25 to 20, inclusive	0.105	0.131	0.183	0.254	0.250	0.114	0.174
19 to 15, inclusive	.036	.054	.119	.215	.206	.042	.111
14 or lower	.016	.011	.033	.142	.104	.008	.053
25 or lower	.157	.196	.335	.612	.560	.164	.339

THE PERSISTENCE OF LOW RELATIVE HUMIDITY

Number of occurrences of consecutive days of low relative humidity, within the limits and in the several day groups as indicated.

TABLE 4

AT SEATTLE, WASH.

GROUPS OF DAYS, RELATIVE HUMIDITY 38 PER CENT, OR LOWER

	Number of days										
	1	2	3	4	5	6	7	8	9	10	11
April	51	16	8	6	3	0	0	0			
May	35	26	8	4	2	4	1	0			
June	35	24	15	5	7	1	1	0			
July	56	26	10	7	2	3	0	2			
August	61	23	10	5	1	1	0	0			
September	34	6	1	3	2	0	0	0			
Season	272	121	52	30	17	9	2	2			

GROUPS OF DAYS, RELATIVE HUMIDITY 30 PER CENT OR LOWER

April	27	8	4	0	1						
May	26	8	1	1	1						
June	37	7	1	0	1						
July	25	4	3	0	0						
August	19	3	1	0	1						
September	9	3	1	0	0						
Season	143	33	11	1	4						

GROUPS OF DAYS, RELATIVE HUMIDITY 25 PER CENT OR LOWER

April	20	3	1	1							
May	16	4	1	1							
June	15	3	0	0							
July	8	1	0	0							
August	4	0	0	0							
September	6	1	0	0							
Season	69	12	2	2							

GROUPS OF DAYS, RELATIVE HUMIDITY 19 PER CENT OR LOWER

April	6	2									
May	7	0									
June	4	0									
July	1	0									
August	0	0									
September	1	0									
Season	19	2									

AT PORTLAND, OREG.

GROUPS OF DAYS, RELATIVE HUMIDITY 38 PER CENT OR LOWER

April	52	30	9	6	3	4	2	0	1		
May	46	22	12	8	3	3	1	0	1		
June	44	22	12	6	2	3	3	3			
July	55	38	22	5	9	3	2	1			
August	66	31	18	6	1	4	2	0	1	0	1
September	33	23	7	3	1						
Season	296	166	80	34	19	17	10	4	3	0	1

GROUPS OF DAYS, RELATIVE HUMIDITY 30 PER CENT OR LOWER

April	32	18	9	5	1	1					
May	37	17	6	2	1						
June	24	15	6	3	0	1	1				
July	52	15	5	3							
August	54	14	6	2	0	1					
September	35	8	3	1							
Season	234	87	35	16	2	3	1				

GROUPS OF DAYS, RELATIVE HUMIDITY 25 PER CENT OR LOWER

April	26	14	7	1							
May	22	8	1	2							
June	22	6	3								
July	29	5									
August	22	5	1	1							
September	16	5	3								
Season	137	43	15	4							

TABLE 4—Continued

AT PORTLAND, OREG.—Continued

GROUPS OF DAYS, RELATIVE HUMIDITY 19 PER CENT OR LOWER

	Number of days										
	1	2	3	4	5	6	7	8	9	10	11
April	11	4									
May	9	3									
June	10	1	1								
July	13										
August	10	1									
September	9	3									
Season	62	12	1								

AT NORTH HEAD, WASH.

GROUPS OF DAYS, RELATIVE HUMIDITY 50 PER CENT OR LOWER

April	15	5									
May	9	3									
June	6										
July	4										
August	5	1									
September	28	8		1							
Season	59	17	0	1							

GROUPS OF DAYS, RELATIVE HUMIDITY 40 PER CENT OR LOWER

April	9	1									
May	3	2									
June	3	0									
July	1	0									
August	5	0									
September	21	1									
Season	42	4									

GROUPS OF DAYS, RELATIVE HUMIDITY 30 PER CENT OR LOWER

April	3	0									
May	1	1									
June	3	0									
July	0	0									
August	3	0									
September	7	0									
Season	15	1									

AT SPOKANE, WASH.

GROUPS OF DAYS, RELATIVE HUMIDITY 25 PER CENT OR LOWER

	Number of days																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
April	72	29	14	6	6	1	0	1	2	0	1	1					
May	69	28	14	9	5	5	0	2	1	1	0	0	0	0	0	0	1
June	42	33	12	7	2	9	6	3	4	4	0	0	0	1	1	0	0
July	32	12	9	9	12	6	2	8	5	2	3	3	1	0	3	1	3
August	25	24	13	10	12	7	5	1	3	3	3	2	2	2	3	1	0
September	54	20	14	8	7	2	1	1	0	0	1	1	0	0	0	0	0
Season	294	146	76	49	44	30	14	16	15	10	8	7	3	3	7	2	4

	Number of days																
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
April																	
May																	
June	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
July	2	1	2	0	1	.1	1	0	0	0	0	0	0	0	1	0	0
August	3	0	0	0	0	0	0	0	0	0	0	0	0	.1	0	0	0
September	1																
Season	6	1	2	0	1	1	1	1	0	0	0	0	0	1	1	1	1

TABLE 4—Continued

AT SPOKANE, WASH.—Continued

GROUPS OF DAYS, RELATIVE HUMIDITY 19 PER CENT OR LOWER

	Number of days																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
April	36	13	4	2	0	1	0	1											
May	43	7	7	3	0	2													
June	34	16	11	8	5	5	3	0	1										
July	55	23	20	7	3	9	6	4	2	5	1	1	1	0	2	0	0	1	
August	45	29	13	13	12	4	3	1	2	1	2	0	0	0	2	0	0	0	1
September	37	12	3	2	0	2													
Season	250	100	58	35	20	23	12	6	6	6	3	1	1	0	4	0	0	1	1

GROUPS OF DAYS, RELATIVE HUMIDITY 14 PER CENT OR LOWER

April	12	3																
May	14	2	0	0	0	1												
June	25	7	2	3														
July	54	20	8	5	4	0	1	0	1									
August	43	19	8	3	3	0	0	1	1	1								
September	16	2	1															

AT WALLA WALLA, WASH.

GROUPS OF DAYS, RELATIVE HUMIDITY 25 PER CENT OR LOWER

	Number of days													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
April	42	17	10	7	2	0	1	1						
May	44	23	11	9	3	3	1	2	1					
June	31	25	11	6	9	4	4	4	4	0	0	0	0	2
July	30	19	13	12	7	3	9	6	3	3	4	3	0	1
August	39	15	14	7	10	4	7	2	3	4	0	0	2	0
September	45	18	6	4	4	0	1							
Season	231	117	65	45	35	14	23	15	11	7	4	3	2	3

	Number of days													
	15	16	17	18	19	20	21	22	23	24	25	29	39	42
April														
May														
June	1	0	1											
July	2	1	1	1			0	1	0	0	2	1	1	1
August	1	1	0	1			0	0	0	0	1			
September														
Season	4	2	2	2			0	1	0	0	3	1	1	1

GROUPS OF DAYS, RELATIVE HUMIDITY 19 PER CENT OR LOWER

	Number of days															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
April	24	7	1	3												
May	31	10	6													
June	39	16	11	5	3	2	2	1								
July	61	23	9	10	4	4	3	5	1	3	2	0	0	0	1	1
August	63	22	14	8	12	1	3	3	1	0	0	1				
September	18	11	1	1	1											
Season	236	89	42	27	20	7	8	9	2	3	2	1	0	0	1	1

GROUPS OF DAYS, RELATIVE HUMIDITY 14 PER CENT OR LOWER

April	11	1	0	1												
May	8	2														
June	20	5	1	1												
July	46	12	9	2	5	2	0	1								
August	46	14	7	3												
September	6	0														
Season	137	34	17	7	5	2	0	1								

TABLE 5.—*The average number of periods (groups of one or more days) of low relative humidity, for the 34-year period*

AT SEATTLE, WASH.

Relative humidity (per cent)	April	May	June	July	August	September	Season
38 or lower	2.5	2.4	2.6	3.1	3.0	1.4	14.9
30 or lower	1.2	1.1	1.7	0.9	0.7	0.4	5.6
25 or lower	0.7	0.6	0.5	0.3	0.1	0.2	2.5
19 or lower	0.2	0.2	0.1	(1)	0	(1)	0.6

[1] Less than 0.05.

AT PORTLAND, OREG.

38 or lower	3.1	2.8	2.8	4.0	3.8	2.0	18.5
30 or lower	1.9	1.8	1.5	2.2	2.3	1.4	11.1
25 or lower	1.4	1.5	0.9	1.0	0.9	0.7	5.9
19 or lower	0.4	0.4	0.4	0.4	0.3	0.4	2.2

AT NORTH HEAD, WASH.

50 or lower	0.59	0.35	0.18	0.12	0.18	0.85	2.26
40 or lower	0.29	0.12	0.09	0.03	0.15	0.56	1.24
30 or lower	0.09	0.06	0.09	0.00	0.09	0.21	0.53

AT SPOKANE, WASH.

25 or lower	3.9	4.0	3.7	3.5	3.5	3.2	21.9
19 or lower	1.7	1.8	2.4	4.1	3.8	1.6	15.5
14 or lower	0.4	0.5	1.1	2.7	1.2	0.6	7.6

AT WALLA WALLA, WASH.

25 or lower	2.4	2.9	3.0	3.6	3.3	2.3	17.4
19 or lower	1.0	1.4	2.3	3.7	3.8	0.9	13.2
14 or lower	0.4	0.3	0.8	2.3	2.1	0.2	5.9

TABLE 6.—*The average duration of periods of low relative humidity for the 34-year period, with date and duration of longest period*

AT SEATTLE, WASH.

Relative humidity (per cent)	April	May	June	July	August	September	Season	Longest period with date
38 or lower	1.7	2.0	2.3	1.9	1.7	1.7	1.9	8; July, 1911 and 1927.
30 or lower	1.6	1.4	1.5	1.2	1.2	1.4	1.4	5; several dates.
25 or lower	1.3	1.4	1.2	1.1	1.0	1.1	1.2	4; April, 1921; May 1898.
19 or lower	1.2	1.0	1.0	1.0	0	1.0	1.0	2; April, 1907 and 1924.

AT PORTLAND, OREG.

38 or lower	2.1	2.1	2.1	2.2	2.2	2.0	2.1	11; August, 1923.
30 or lower	1.9	1.6	1.9	1.5	1.4	1.4	1.6	7; July, 1898.
25 or lower	1.6	1.5	1.4	1.2	1.3	1.3	1.4	4; several dates.
19 or lower	1.3	1.2	1.2	1.0	1.1	1.2	1.2	3; June, 1920.

AT NORTH HEAD, WASH.

50 or lower	1.2	1.2	1.0	1.0	1.2	1.4	1.3	4; September, 1926.
40 or lower	1.1	1.5	1.0	1.0	1.0	1.2	1.2	Do.
30 or lower	1.0	1.5	1.0	0	1.0	1.0	1.1	2; May, 1922.

AT SPOKANE, WASH.

25 or lower	2.0	2.1	3.3	6.0	5.8	2.8	3.6	34; June-July, 1925.
19 or lower	1.7	1.7	2.3	3.3	3.4	1.9	2.6	19; August, 1904.
15 or lower	1.2	1.4	1.4	1.9	2.1	1.2	1.8	10; August, 1894.

AT WALLA WALLA, WASH.

25 or lower	2.0	2.1	3.4	5.2	5.3	2.1	3.6	42; July–August, 1910.
19 or lower	1.5	1.5	2.0	2.9	2.5	1.6	2.3	16; July, 1911.
14 or lower	1.2	1.2	1.3	1.9	1.5	1.3	1.6	8; July, 1911.

TABLE 7.—*The number of days with low relative humidity, within the limits indicated, for each year of the period 1894–1927*

Year	For Seattle					For Portland				
	Per cent of relative humidity, 5 p. m.									
	38–31	30–26	25–20	19	Total	38–31	30–26	25–20	19	Total
1894	12	0	0	0	12	24	0	2	1	36
1895	25	8	5	2	40	27	13	8	7	55
1896	30	6	2	0	38	25	15	6	3	49
1897	10	2	2	0	14	24	15	10	5	54
1898	20	5	9	1	35	17	14	12	7	50
1899	19	7	2	1	29	19	3	3	0	25
1900	16	6	1	1	24	17	7	2	2	28
1901	17	2	3	0	22	12	4	3	1	20
1902	27	3	4	1	35	33	5	0	6	44
1903	14	2	1	1	18	19	10	1	1	31
1904	26	1	3	1	31	37	10	11	6	64
1905	4	5	2	0	11	23	7	7	4	41
1906	28	9	1	1	39	30	10	7	2	49
1907	21	8	1	2	32	23	11	8	5	47
1908	6	1	0	0	7	15	8	0	0	23
1909	14	9	2	0	25	12	11	8	2	33
1910	11	1	0	0	12	25	8	4	0	37
1911	25	5	3	0	33	14	5	7	3	29
1912	18	1	3	2	24	8	5	3	0	16
1913	5	0	0	0	5	14	7	2	0	23
1914	15	2	1	0	18	22	12	3	1	38
1915	12	1	0	0	13	19	6	4	0	29
1916	23	6	3	0	32	23	9	4	3	39
1917	25	5	1	1	32	23	11	4	0	38
1918	23	9	8	0	40	25	21	17	6	69
1919	34	8	1	0	43	27	14	10	5	56
1920	21	3	1	1	26	21	14	5	6	46
1921	17	3	3	0	23	33	6	2	2	43
1922	29	5	3	1	38	20	8	7	1	36
1923	22	5	3	0	30	15	12	2	3	32
1924	25	7	7	2	41	24	11	11	2	48
1925	29	5	2	1	37	7	6	1	2	16
1926	49	7	5	4	65	22	9	12	2	45
1927	19	13	3	0	35	27	9	10	0	46

TABLE 7.—*The number of days with low relative humidity, within the limits indicated, for each year of the period 1894–1927*—Con.

Year	For North Head				For Spokane				For Walla Walla			
	Per cent of relative humidity, 5 p. m.											
	50–41	40–31	30	Total	25–20	19–15	14	Total	25–20	19–15	14	Total
1894	2	1	1	4	23	28	22	73	34	13	4	51
1895	3	0	0	3	30	31	38	99	39	23	3	65
1896	5	3	0	8	31	36	19	86	18	4	2	24
1897	2	1	1	4	32	19	5	56	37	11	2	50
1898	2	0	1	3	51	37	16	104	23	2	1	26
1899	1	2	0	3	35	12	7	54	20	13	8	41
1900	1	0	0	1	40	24	11	75	18	9	0	27
1901	2	0	1	3	29	20	8	57	11	2	0	13
1902	2	0	1	3	47	23	1	71	5	1	0	6
1903	1	0	1	2	47	17	5	69	16	5	1	22
1904	2	0	0	2	42	28	24	94	28	4	0	32
1905	3	1	1	5	35	29	11	75	21	11	3	35
1906	2	0	0	2	48	27	11	86	22	12	2	36
1907	0	1	1	2	41	13	1	55	37	13	2	52
1908	0	0	0	0	40	31	19	90	35	27	16	78
1909	1	0	0	1	40	38	13	91	37	34	27	98
1910	1	1	0	2	42	30	20	92	46	30	33	109
1911	1	0	0	1	42	23	8	73	39	26	29	94
1912	0	3	0	3	34	15	2	51	36	27	8	86
1913	0	2	1	3	44	19	4	67	42	34	10	86
1914	1	0	0	1	28	35	17	80	27	33	16	76
1915	0	0	0	0	35	23	8	66	42	26	12	80
1916	0	1	1	2	40	25	5	70	35	15	4	54
1917	1	0	0	1	35	28	27	90	33	29	18	80
1918	3	0	0	3	40	44	15	99	50	31	8	89
1919	4	1	0	5	49	32	23	104	46	29	17	92
1920	0	1	0	1	50	26	8	84	34	28	19	81
1921	1	1	0	2	39	18	11	68	51	24	14	89
1922	1	1	3	5	45	33	17	95	38	21	10	69
1923	0	0	0	0	38	28	5	71	37	29	4	70
1924	0	4	1	5	37	47	29	113	33	46	19	98
1925	3	0	3	6	30	44	16	90	25	35	7	67
1926	2	6	1	9	31	40	24	95	34	33	18	85
1927	1	0	1	2	29	16	5	50	33	22	12	67

FOREST-FIRE WEATHER IN CENTRAL MASSACHUSETTS[1]

By PAUL W. STICKEL, Assistant Silviculturist

[Northeastern Forest Experiment Station, United States Forest Service, Amherst, Mass., February 29, 1928]

The forest fire hazard in the Northeast is most acute during two distinct periods in the year: (1) In the spring, from the disappearance of the last snow to the complete foliation of the deciduous trees; (2) in the fall, from the beginning of defoliation until the ground is covered with snow. While the trees and shrubs are in a dormant state, the leaf litter—the principal carrier of fire in the Northeast—is fully exposed to the drying-out action of wind and warm dry weather. Between the spring and fall fire seasons the danger is reduced materially by the influence of the tree foliage upon the leaf litter. In other words, the leaves intercept the sun's rays and diminish wind velocity, thereby lessening the rate of evaporation from the duff, which in turn decreases the fire danger.

The above discussion is equally true for open grassland areas. Until the new crop of green vegetation covers the pastures and meadows in the spring and the snow covers the dead plant remains in the fall, conditions are similar to those which are found during hazardous periods on forested lands.

In the present paper the discussion of the correlation between weather and forest fires will be limited to the conditions in central Massachusetts during the spring of 1927. The fire records are for the following counties: Worcester County, the western half of Middlesex County, and the eastern half of Franklin, Hampshire, and Hampden Counties. The total area of the region is approximately 1,750,000 acres, the greater part of which is included in the so-called white pine region. The meteorological data of the Petersham fire-weather station, maintained jointly by the Northeastern Forest Experiment Station and the Harvard Forest, were used for comparing the weather and the occurrence of fires. At Petersham two observation stations were located in the white pine type—one in a clear-cut area and the other in an adjacent mature stand of northern white pine and eastern hemlock. At each station measurements were taken of duff moisture content of the surface layer and at 1 inch depth, and duff temperature, as well as the regular observations of air temperature, relative humidity, evaporation, wind velocity, and rainfall. Atmometers (using the Livingston porous bulbs and Nichols mountings) placed at the level of the leaf litter were employed in securing evaporation data. Special mention should be made of the fact that the three-cup Robinson anemometers were placed only 3½ feet above the ground. Four observations were taken daily: at 8 a. m., 11 a. m., 2 p. m., and 5 p. m. In the tables and graphs which are presented herewith the 2 p. m. records of the station in the clear-cut area are used. These records are chosen (1) because they represent the maximum degree of hazard; (2) because the average daily minimum relative humidity and average daily maxima of air temperature, evaporation, solar radiation, and wind movement occur around 2 p. m. These are all conditions which tend to create a low duff moisture content and consequently a high fire hazard.

Weather conditions during the early part of 1927 were especially favorable for the inception and spread of forest fires. A mild open winter with moderate snowfall was followed by a very dry, warm spring. The transition began early in March and by the end of that month was

[1] The author wishes to thank Mr. A. W. Gottlieb for his assistance in collecting the data at the Petersham, Mass., fire-weather station maintained jointly with the Harvard Forest.